Coopetitions in machine learning: case studies

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Background and Motivations

Classical challenges in Machine Learning are typically built around competitive winner-take-all models, in which mutually exclusive teams try to independently solve a problem to win a prize. The notion of ***coopetition*** has been used in game theory, econometrics, and political science to describe systems in which agents have a partial congruence of interest and ***cooperate with each other*** to reach a higher value than by merely competing. We want to use the notion of coopetition in Machine Learning by organizing challenges in which ***participants collaborate*** to some extent. In this paper we compare and contrast new designs we have been exploring under the *CodaLab* platform (http://codalab.org). The "*classical approach*" can be divided as follows:

• **Running recurrent challenges**: cooperation is achieved by disseminating the results of each competition by means of workshops and proceedings. VOC (2005-2012) and ImageNet challenges (since 2010), both focusing on image recognition, and the ChaLearn gesture challenges (since 2011 on multi-modal gesture recognition) are examples of recurrent challenges.

• **Encouraging team merges**: organizers provide on-line feedback on progress made and a discussion forum to let competitors freely exchange ideas and authorize the merger of teams. In the Netflix prize (2009), for example, the performance imposed by the challenge protocol could only be achieved with a team merger after a long period of performance stagnation.

New coopetition designs

We are interested in encouraging two types of partial contributions:

• **Sub-task contribution**: a team may contribute with a module or a key idea, which, alone, is insufficient to get good overall performance.

• **Snowball effect**: teams that break the ice by entering early in the competition or that make a sudden leap in performance make an important contribution: they attract interest and push all other teams to match the new best result (which often happens within hours).

Reward mechanisms and game theoretic backing

Game theory provides a framework to reason about problems in economics, political science, psychology, and biology that goes well beyond the study of recreational games. The essential elements of a game are **P**layers, **A**ctions, **P**ayoffs, and **I**nformation [1] (PAPI). **Challenges are games participants are players**. *The task of organizers is to devise appropriate rules and facilitate game playing*.

Actions include resource sharing or the submission of an entry to the competition; *Payoffs* include prizes, visibility and work dissemination; *Information* are computed resource rating, available data/software and acquired knowledge during the competition.

CodaLab Competition and Worksheets

• ***CodaLab competitions*** is a powerful framework for running competitions that involve code (or prediction files) submission. You can either participate in an existing competition or host a new competition.

• ***CodaLab worksheets*** is a collaborative code-sharing environment, which aims to both accelerate the rate of research and make it more sound.

Both systems use the concept of ***bundles***, which are immutable files/directories that represents code, data, and results of an experimental pipeline. In addition, they are ***complementary***. For instance, on one hand, researchers can submit *bundles* generated on worksheets to a competition. On the other hand, organizers can download/upload *bundles* from/to worksheets. We have been exploiting this kind of integration in our development instance of *CodaLab* in order to build the new generation of coopetitions in Machine Learning.

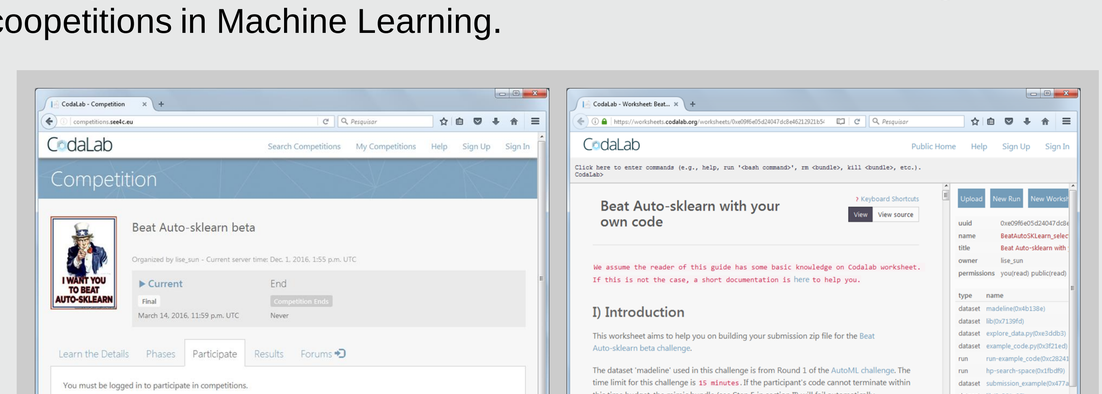


Figure 1: CodaLab front-end illustrations. CodaLab Competition (left) and Worksheets (right).

Our current coopetition design

We are exploring several types of coopetition designs to implement such ideas. Some case studies are briefly described next.

• **Beat Auto-sklearn beta:** encourage participants to build a stronger ensemble solution. This new coopetition design ***requires a more complex scoring system***. Additional information: http://automl.chalearn.org

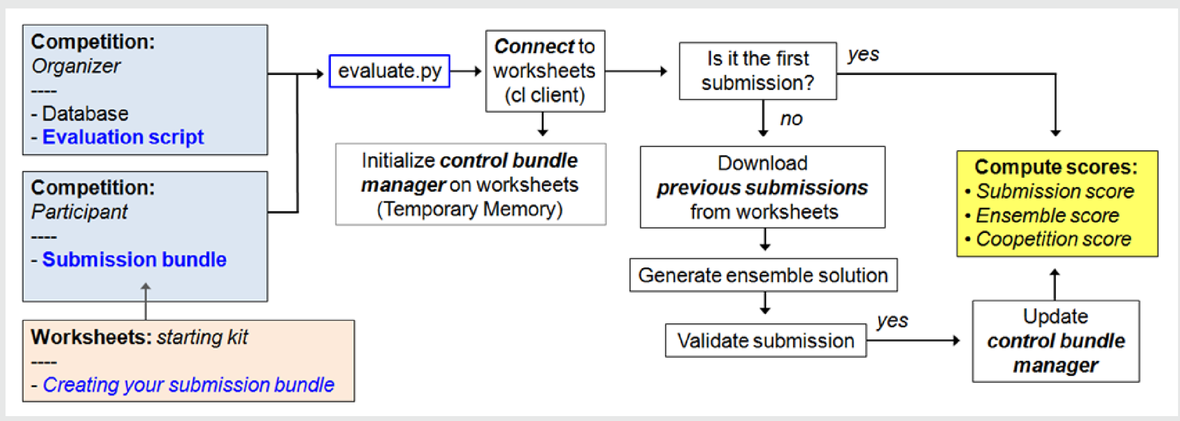
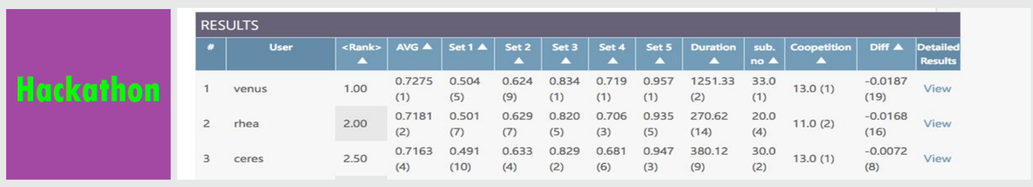


Figure 2: Proposed coopetition design and integration strategy, which ***allow us to download and upload submission files to a temporary worksheet***, *and compute ensemble predictions from that*.

Previous Coopetition examples

• **Petersburg hackathon – AutoML Round 1 ++, Aug. 4. 2015:** encourage code sharing during the competition by rewarding number of downloads, which is taken into account in the final scoring. This competition attracted 19 teams (composed by 6 participants).



#	User	<Rank>	AVG	Set 1	Set 2	Set 3	Set 4	Set 5	Duration	sub. no	Coopetition	Diff	Detailed Results
1	venus	1.00	0.7275 (1)	0.504 (5)	0.624 (9)	0.834 (1)	0.719 (1)	0.957 (1)	1251.33 (2)	33.0 (1)	13.0 (1)	-0.0187 (19)	View
2	rhea	2.00	0.7181 (2)	0.501 (7)	0.629 (7)	0.820 (5)	0.706 (3)	0.935 (5)	270.62 (14)	20.0 (4)	11.0 (2)	-0.0168 (16)	View
3	ceres	2.50	0.7163 (4)	0.491 (10)	0.633 (4)	0.829 (2)	0.681 (6)	0.947 (3)	380.12 (9)	30.0 (2)	13.0 (1)	-0.0072 (8)	View

Figure 3: Leaderboard illustration of the Pertersburg hackathon.

• **Personality Trait challenge – First Impressions (2nd round, ICPR 2016)**: also encourage code sharing during the competition by rewarding number of downloads. This coopetition attracted 62 participants.

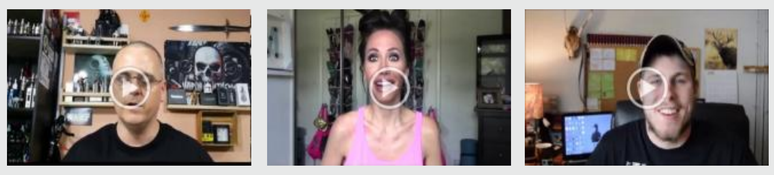


Figure 4: dataset illustration samples.

#	Submission Id	User	Phase	Date	Description	AVG	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness	Coopetition	Likes	Downloads
2	272541	vismay	Final Evaluation	Aug 15 2016		0.9124	0.9157	0.9110	0.9141	0.9103	0.9110	1.0000	0	(4 dls)

Table 1: Leaderboard illustration, including number of downloads and coopetition score for a specific submission.

Next Challenges

• **New score systems:** how to encourage collaboration even more?
• **Meta competition – The challenge of challenges protocol:** participants (i.e. future challenge organizers) submit their design for a real challenge. The one who attracts most participants wins.

[1] Eric Rasmussen. Games and Information. An Introduction to Game Teory. Oxford. 1989

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Additional information: http://automl.chalearn.org